Report on the FCC and IC Testing of:

DETNET SOUTH AFRICA (PTY) LTD
Free standing blast controller, Model: DigiShot Plus
Omni directional aerial, Model: DIPL-A0049
Universal Mains Charger, Model: GS25B18-P1J

In accordance with FCC 47 CFR Part 15C, Industry Canada RSS-247 and Industry Canada RSS-GEN

Add value.
Inspire trust.

Prepared for: DETNET SOUTH AFRICA (PTY) LTD
Block 1B, Founders Hill Office Park
Centenary Road, Modderfontein
P O Box 10, 1645, SOUTH AFRICA

FCC ID: 2ARNH-09230850 IC: 24476-09230850

COMMERCIAL-IN-CONFIDENCE

Document Number: 75943833-03 | Issue: 02

SIGNATURE			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Simon Bennett	Chief Engineer	Authorised Signatory	09 April 2019

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD document control rules.

ENGINEERING STATEMENT

The measurements shown in this report were made in accordance with the procedures described on test pages. All reported testing was carried out on a sample equipment to demonstrate limited compliance with FCC 47 CFR Part 15C, Industry Canada RSS-247 and Industry Canada RSS-GEN. The sample tested was found to comply with the requirements defined in the applied rules.

SIGNATURE			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Daniel Bishop	Test Engineer	Testing	09 April 2019
Graeme Lawler	Test Engineer	Testing	09 April 2019

FCC Accreditation
90987 Octagon House, Fareham Test Laboratory

Industry Canada Accreditation
IC2932B-1 Octagon House, Fareham Test Laboratory

EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with FCC 47 CFR Part 15C: 2017, Industry Canada RSS-247: Issue 2 (2017-02) and Industry Canada RSS-GEN: Issue 5 (2018-04).

TÜV SÜD
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Contents

1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	18 December 2018
2	To amend the FCC and IC IDs and model name	09 April 2019

Table 1

1.2 Introduction

Applicant	DETNET SOUTH AFRICA (PTY) LTD
Manufacturer	DETNET SOUTH AFRICA (PTY) LTD
Model Number(s)	Free standing blast controller, DigiShot Plus Omni directional aerial, DIPL-A0049 Universal Mains Charger, GS25B18-P1J
Serial Number(s)	Free standing blast controller, 1030002244 Omni directional aerial, Not Serialised (75943833-TSR0014) Universal Mains Charger, Not Serialised (75943833-TSR0013)
Hardware Version(s)	Hardware rev.11 PCB rev.3
Software Version(s)	SVN 34340
Number of Samples Tested	1 plus ancillaries
Test Specification/Issue/Date	FCC 47 CFR Part 15C: 2017 Industry Canada RSS-247: Issue 2 (2017-02) Industry Canada RSS-GEN: Issue 5 (2018-04)
Order Number Date	4500351687 18-September-2018
Date of Receipt of EUT	11-October-2018 and 28-November-2018
Start of Test	10-October-2018
Finish of Test	11-December-2018
Name of Engineer(s)	Daniel Bishop and Graeme Lawler
Related Document(s)	ANSI C63.10 (2013) KDB 662911 D01 v02r02

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 15C, Industry Canada RSS-247 and Industry Canada RSS-GEN is shown below.

Section	Specification Clause			Test Description	Result	Comments/Base Standard
	Part 15C	RSS-247	RSS-GEN			
Configuration and Mode: 902 to 928 MHz FHSS Transmitter						
2.1	15.247 (b)	5.4	6.12	Maximum Conducted Output Power	Pass	ANSI C63.10 (2013) KDB 662911 D01 v02r02
2.2	15.247 (a)(1)	5.1	-	Frequency Hopping Systems - Average Time of Occupancy	Pass	ANSI C63.10 (2013)
2.3	15.247 (a)(1)	5.1	-	Frequency Hopping Systems - Channel Separation	Pass	ANSI C63.10 (2013)
2.4	15.247 (a)(1)	5.1	-	Frequency Hopping Systems - Number of Hopping Channels	Pass	ANSI C63.10 (2013)
2.5	15.247 (d)	5.5	-	Authorised Band Edges	Pass	ANSI C63.10 (2013)
2.6	15.247 (d) and 15.205	5.5	6.13	Spurious Radiated Emissions	Pass	ANSI C63.10 (2013)
2.7	15.247 (a)(1)	5.1		Frequency Hopping Systems - 20 dB Bandwidth	Pass	ANSI C63.10 (2013)
2.8	15.205	-	8.10	Restricted Band Edges	Pass	ANSI C63.10 (2013)

Table 2

1.4 Application Form

EQUIPMENT DESCRIPTION	
Model Name/Number	DigiShot Plus
Part Number	1480002C5
Hardware Version	Hardware rev.11 PCB rev.3
Software Version	SVN 34340
FCC ID (if applicable)	2ARNH-09230850
Industry Canada ID (if applicable)	24476-09230850
Technical Description (Please provide a brief description of the intended use of the equipment)	Free standing electronic detonator blast controller. This unit integrates a EDP-209 (AC4490 transceiver) operating in the 902 MHz to 928 MHz frequency band. It uses frequency hopping technology over 32 channels with an output power of approximately 30 dBm and a Tx duty cycle of approximately 2.9%. The units also include an AC PSU for charging and/or operation, a serial port to download / printing of the blast plan and an omni directional antenna.

INTENTIONAL RADIATORS									
Technology	Frequency Band (MHz)	Conducted Declared Output Power (dBm)	Antenna Gain (dBi)	Supported Bandwidth (s) (MHz)	Modulation Scheme(s)	ITU Emission Designator	Test Channels (MHz)		
							Bottom	Middle	Top
RF	900	30.0	2.1	902 -928 MHz			902	915	928

UN-INTENTIONAL RADIATOR	
Highest frequency generated or used in the device or on which the device operates or tunes	928 MHz
Lowest frequency generated or used in the device or on which the device operates or tunes	1200 Hz
Class A Digital Device (Use in commercial, industrial or business environment) ☒ Class B Digital Device (Use in residential environment only) ☐	

Power Source			
AC	Single Phase	Three Phase	Nominal Voltage
External DC	Nominal Voltage		Maximum Current
Battery	Nominal Voltage		Battery Operating End Point Voltage
	12V		11.2V
Can EUT transmit whilst being charged?			Yes ☐ No ☒

EXTREME CONDITIONS					
Maximum temperature	60	°C	Minimum temperature	-30	°C

Ancillaries

Please list all ancillaries which will be used with the device.
Moulded Dipole Antenna with magnetic base

ANTENNA CHARACTERISTICS					
☒	Antenna connector		State impedance	50	Ohm
☐	Temporary antenna connector		State impedance		Ohm
☐	Integral antenna	Type			
☐	External antenna	Type			

I hereby declare that the information supplied is correct and complete.

Name: H van der Walt

Position held: Quality and Compliance Manager Date: 2018-10-01

1.5 Product Information

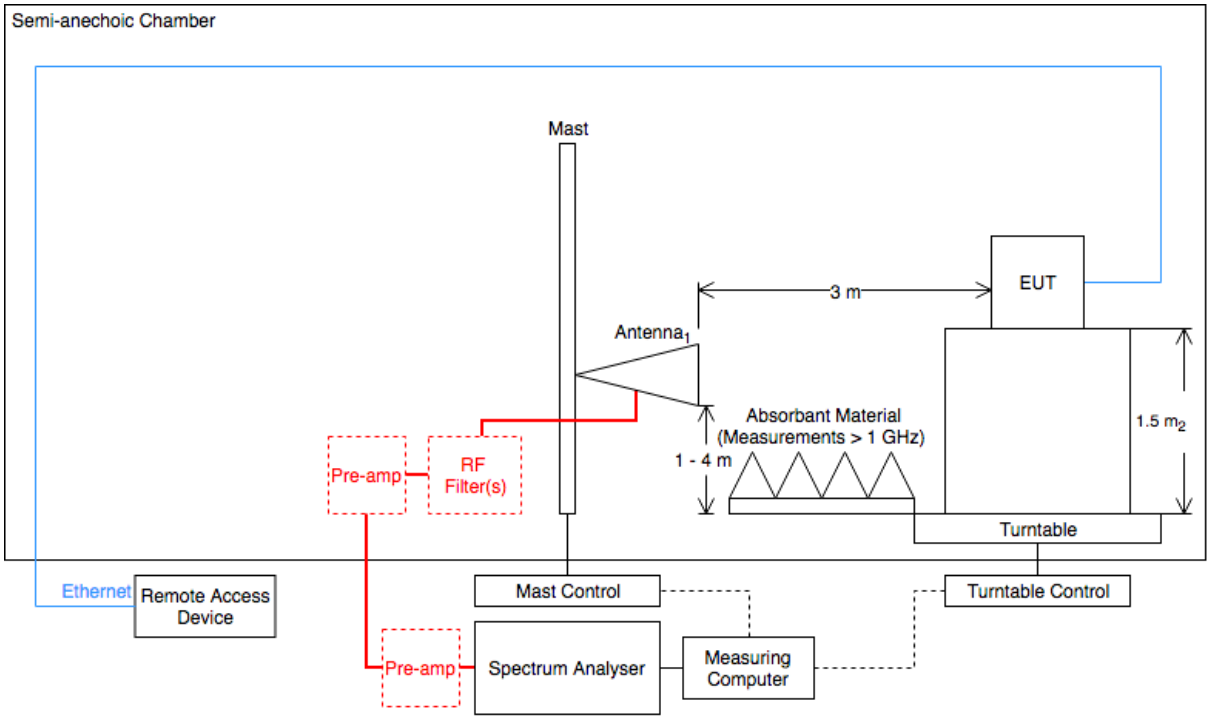
1.5.1 Technical Description

Free standing electronic detonator blast controller.

This unit integrates a EDP-209 (AC4490 transceiver) operating in the 902 MHz to 928 MHz frequency band. It uses frequency hopping technology over 32 channels with an output power of approximately 30 dBm and a Tx duty cycle of approximately 2.9%.

The units also include an AC PSU for charging and/or operation, a serial port to download / printing of the blast plan and an omni directional antenna.

1.5.2 Test Setup Diagram(s)



1 Antenna is boresighted for measurements < 1 GHz.
2 Height from the EUT to ground is 0.8 m for measurements < 1 GHz.

Figure 1 – Radiated Emissions Setup

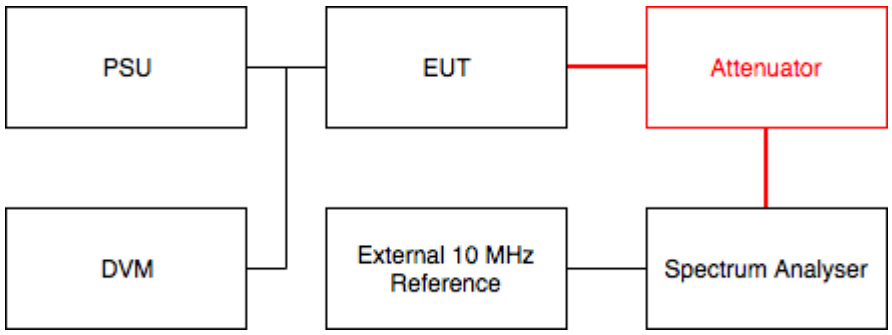


Figure 2 – Conducted Test(s) Setup

1.5.3 EUT Configuration and Rationale for Radiated Spurious Emissions

The EUT was placed on the non-conducting platform in a manner typical of a normal installation.

The EUT was orientated as shown in the setup photographs.

Ports on the EUT were terminated with loads as described in ANSI C63.4 clause 6.2.4. Where multiple connectors of the same type, additional interconnecting cables were connected, and pre-scans performed to determine whether the level of the emissions were increased by >2 dB.

1.6 Deviations from the Standard

No deviations from the applicable test standard were made during testing.

1.7 EUT Modification Record

The table below details modifications made to the EUT during the test programme.
The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
Free standing blast controller, Serial Number: 1030002244			
0	As supplied by the customer	Not Applicable	Not Applicable
Omni directional aerial, Serial Number: Not Serialised (75943833- TSR0014)			
0	As supplied by the customer	Not Applicable	Not Applicable
Universal Mains Charger Serial Number: Not Serialised (75943833-TSR0013)			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 3

1.8 Test Location

TÜV SÜD conducted the following tests at our Fareham Test Laboratory.

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: 902 to 928 MHz FHSS Transmitter		
Maximum Conducted Output Power	Daniel Bishop	UKAS
Frequency Hopping Systems - Average Time of Occupancy	Daniel Bishop	UKAS
Frequency Hopping Systems - Channel Separation	Daniel Bishop	UKAS
Frequency Hopping Systems - Number of Hopping Channels	Daniel Bishop	UKAS
Authorised Band Edges	Graeme Lawler	UKAS
Spurious Radiated Emissions	Graeme Lawler	UKAS
Frequency Hopping Systems - 20 dB Bandwidth	Daniel Bishop	UKAS
Restricted Band Edges	Graeme Lawler	UKAS

Table 4

Office Address:

Octagon House
Concorde Way
Segensworth North
Fareham
Hampshire
PO15 5RL
United Kingdom

2 Test Details

2.1 Maximum Conducted Output Power

2.1.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (b)
Industry Canada RSS-247, Clause 5.4
Industry Canada RSS-GEN, Clause 6.12

2.1.2 Equipment Under Test and Modification State

Free standing blast controller, S/N: 1030002244 - Modification State 0

2.1.3 Date of Test

11-October-2018

2.1.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 7.8.5.

2.1.5 Environmental Conditions

Ambient Temperature	21.4 °C
Relative Humidity	44.5 %

2.1.6 Test Results

902 to 928 MHz FHSS Transmitter

Frequency (MHz)	Maximum Output Power	
	dBm	mW
902	28.71	743.019
915	28.08	642.688
928	28.84	765.597

Table 5 - Maximum Conducted Output Power Results

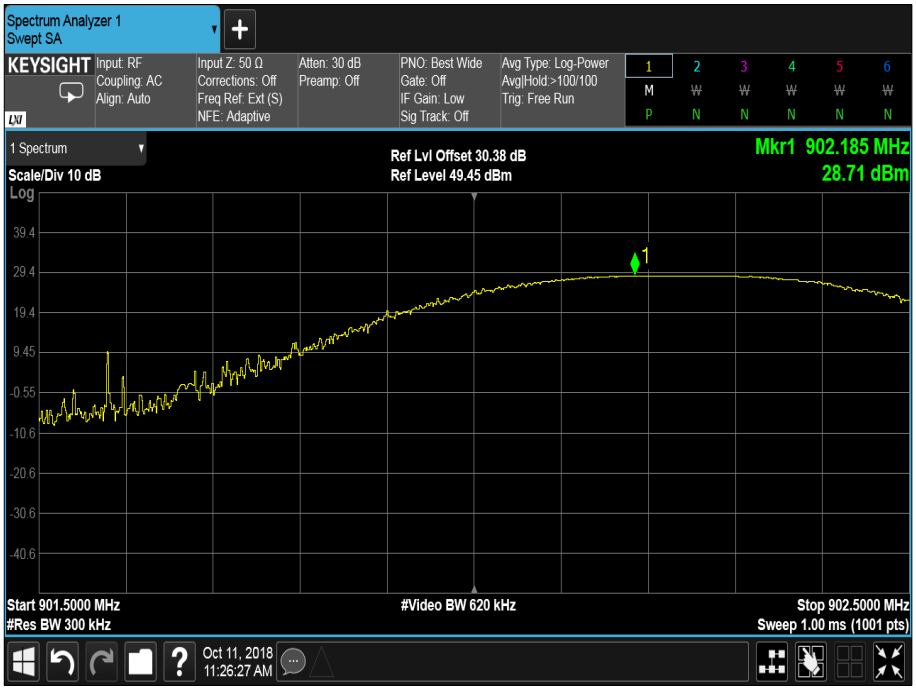


Figure 3 - 902 MHz - Maximum Output Power

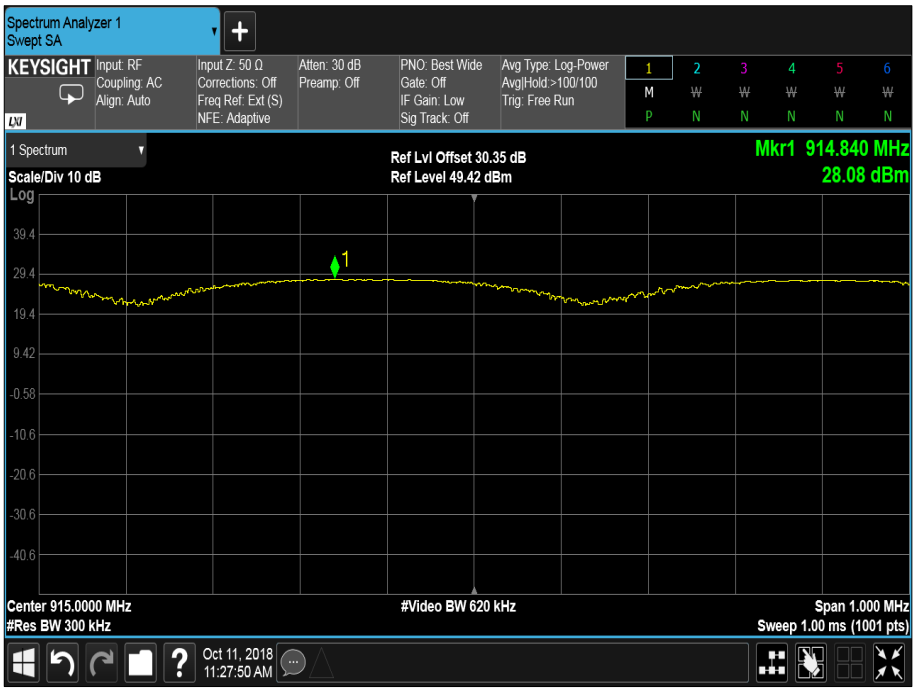


Figure 4 - 915 MHz - Maximum Output Power

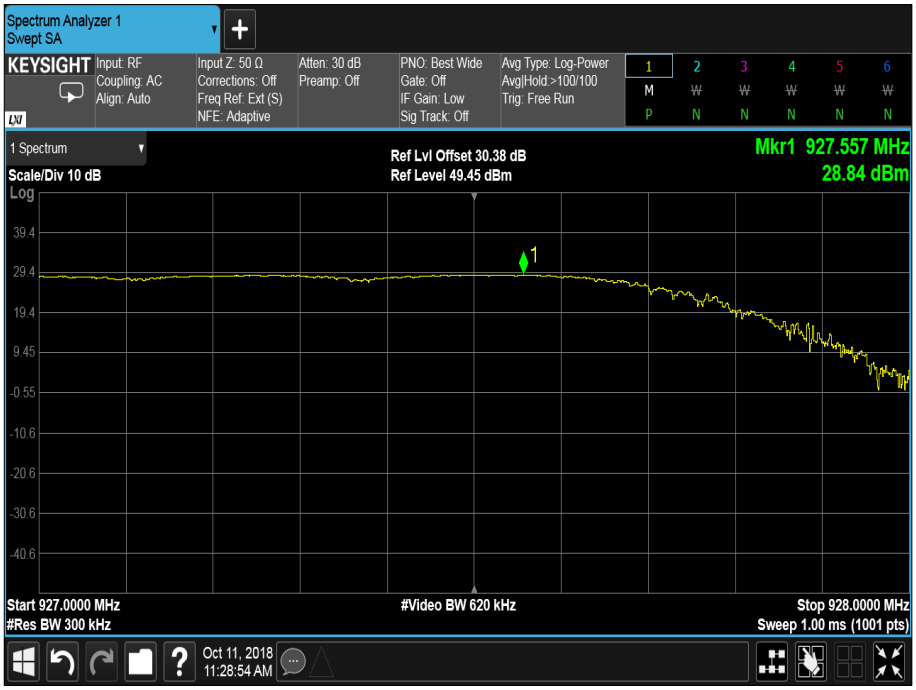


Figure 5 - 928 MHz - Maximum Output Power

FCC 47 CFR Part 15, Limit Clause 15.247 (b)(2)

For frequency hopping systems operating in the 902–928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels.

Industry Canada RSS-247, Limit Clause 5.4 (a)

For FHSs operating in the band 902-928 MHz, the maximum peak conducted output power shall not exceed 1.0 W, and the e.i.r.p. shall not exceed 4 W if the hopset uses 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W and the e.i.r.p. shall not exceed 1 W if the hopset uses less than 50 hopping channels.

2.1.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2019
Hygrometer	Rotronic	A1	1388	12	20-Jun-2019
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	17-Oct-2018
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2019
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	22-Oct-2018
Attenuator (30dB, 100W)	Weinschel	48-30-43	4871	12	17-Jul-2019
EXA	Keysight Technologies	N9010B	4969	12	21-Dec-2018

Table 6

2.2 Frequency Hopping Systems - Average Time of Occupancy

2.2.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (a)(1)
Industry Canada RSS-247, Clause 5.1

2.2.2 Equipment Under Test and Modification State

Free standing blast controller, S/N: 1030002244 - Modification State 0

2.2.3 Date of Test

10-October-2018 to 11-October-2018

2.2.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 7.8.4.

2.2.5 Environmental Conditions

Ambient Temperature	21.4 °C
Relative Humidity	44.5 %

2.2.6 Test Results

902 to 928 MHz FHSS Transmitter

Dwell Time (ms)	Number of Transmissions	Average Occupancy Time (ms)
2.960	21	62.16

Table 7

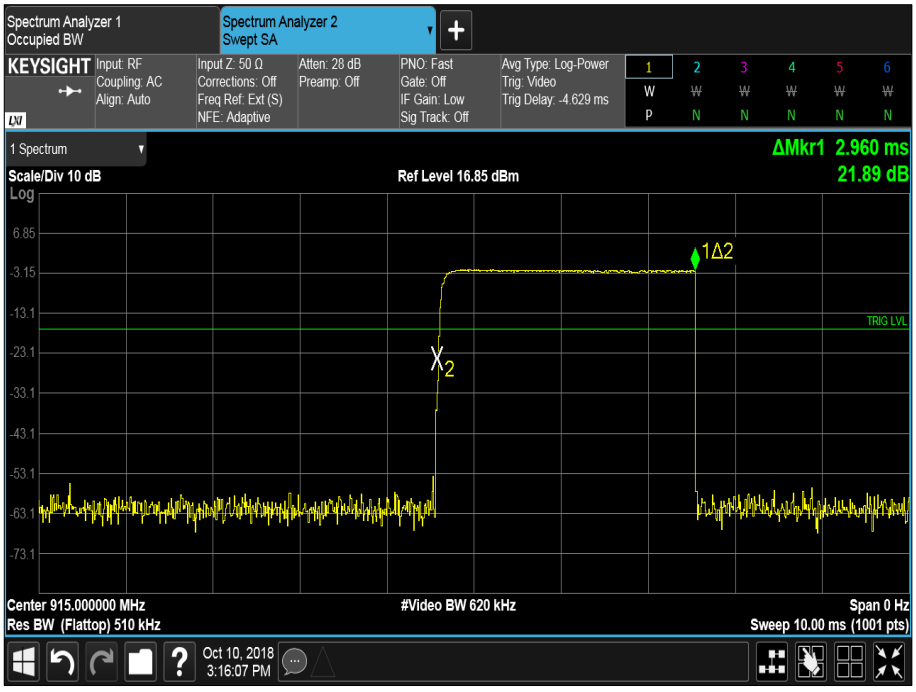


Figure 6 - Dwell Time

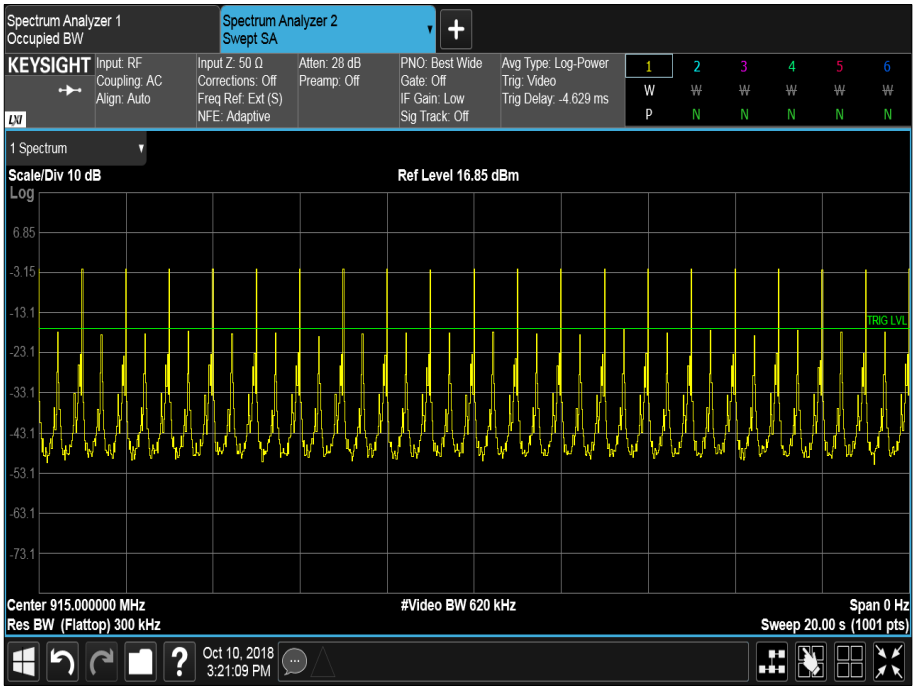


Figure 7 - Total Average Time of Occupancy

FCC 47 CFR Part 15, Limit Clause (a)(1)(i)

For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Industry Canada RSS-247, Limit Clause 5.1 (c)

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period.

2.2.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2019
Hygrometer	Rotronic	A1	1388	12	20-Jun-2019
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	17-Oct-2018
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2019
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	22-Oct-2018
Attenuator (30dB, 100W)	Weinschel	48-30-43	4871	12	17-Jul-2019
EXA	Keysight Technologies	N9010B	4969	12	21-Dec-2018

Table 8

2.3 Frequency Hopping Systems - Channel Separation

2.3.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (a)(1)
Industry Canada RSS-247, Clause 5.1

2.3.2 Equipment Under Test and Modification State

Free standing blast controller, S/N: 1030002244 - Modification State 0

2.3.3 Date of Test

11-October-2018

2.3.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 7.8.2.

2.3.5 Environmental Conditions

Ambient Temperature	21.4 °C
Relative Humidity	44.5 %

2.3.6 Test Results

902 to 928 MHz FHSS Transmitter

Channel Separation (MHz)
0.530
0.250

Table 9

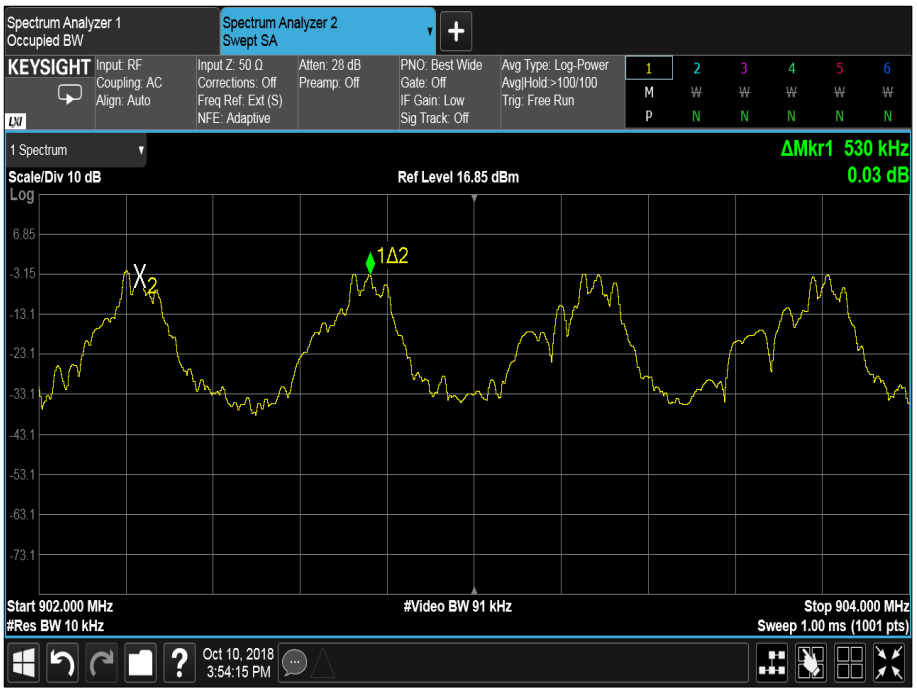


Figure 8

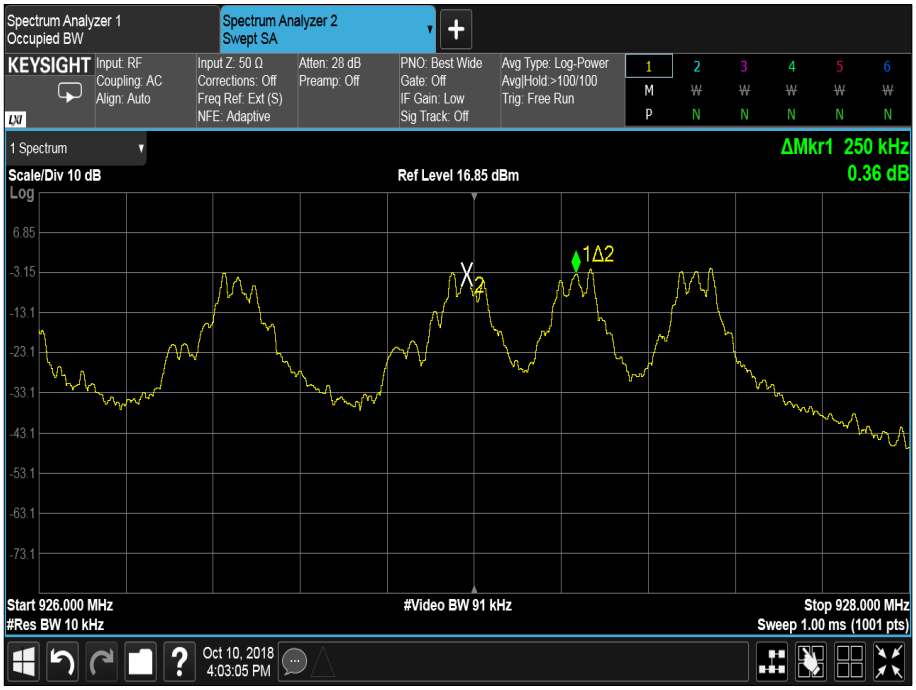


Figure 9

Two different channel separation figures were observed. At the top channel, three channels are spaced closer together than in the rest of the signal, causing the channel separation to be halved for these three channels when compared to the rest of the signal.

FCC 47 CFR Part 15, Limit Clause 15.247 (a)(1)(i)

If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Industry Canada RSS-247, Limit Clause 5.1 (c)

For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

2.3.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2019
Hygrometer	Rotronic	A1	1388	12	20-Jun-2019
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	17-Oct-2018
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2019
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	22-Oct-2018
Attenuator (30dB, 100W)	Weinschel	48-30-43	4871	12	17-Jul-2019
EXA	Keysight Technologies	N9010B	4969	12	21-Dec-2018

Table 10

2.4 Frequency Hopping Systems - Number of Hopping Channels

2.4.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (a)(1)
Industry Canada RSS-247, Clause 5.1

2.4.2 Equipment Under Test and Modification State

Free standing blast controller, S/N: 1030002244 – Modification State 0

2.4.3 Date of Test

11-October-2018

2.4.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 7.8.3.

2.4.5 Environmental Conditions

Ambient Temperature	21.4 °C
Relative Humidity	44.5 %

2.4.6 Test Results

<u>902 to 928 MHz FHSS Transmitter</u>

Number of Hopping Channels: 50

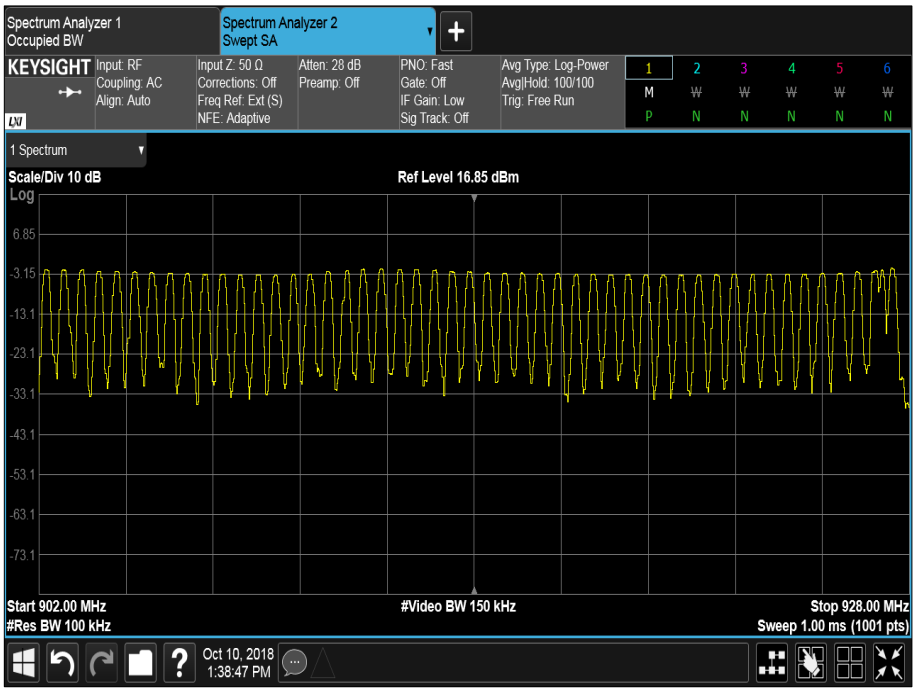


Figure 10 – Measurement Frequency Range: 902 MHz to 928 MHz

FCC 47 CFR Part 15, Limit Clause 15.247 (a)(1)(i) and Industry Canada RSS-247, Limit Clause 5.1 (3)

If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies.

If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies.

2.4.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2019
Hygrometer	Rotronic	A1	1388	12	20-Jun-2019
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	17-Oct-2018
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2019
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	22-Oct-2018
Attenuator (30dB, 100W)	Weinschel	48-30-43	4871	12	17-Jul-2019
EXA	Keysight Technologies	N9010B	4969	12	21-Dec-2018

Table 11

2.5 Authorised Band Edges

2.5.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (d)
Industry Canada RSS-247, Clause 5.5

2.5.2 Equipment Under Test and Modification State

Free standing blast controller, S/N: 1030002244 - Modification State 0
GS25B18-P1J, S/N: N/A - Modification State 0
DIPL-A0049, S/N: Not Serialised (75943833- TSR0014) - Modification State 0

2.5.3 Date of Test

27-November-2018

2.5.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 6.10.4.

The EUT could not be operated without hopping (i.e. on static channels), therefore this test was only performed with hopping enabled.

2.5.5 Environmental Conditions

Ambient Temperature	18.1 °C
Relative Humidity	47.0 %

2.5.6 Test Results

902 to 928 MHz FHSS Transmitter

Mode	Frequency (MHz)	Measured Frequency (MHz)	Level (dBc)
Hopping	902	902	-27.20
Hopping	928	928	-40.81

Table 12

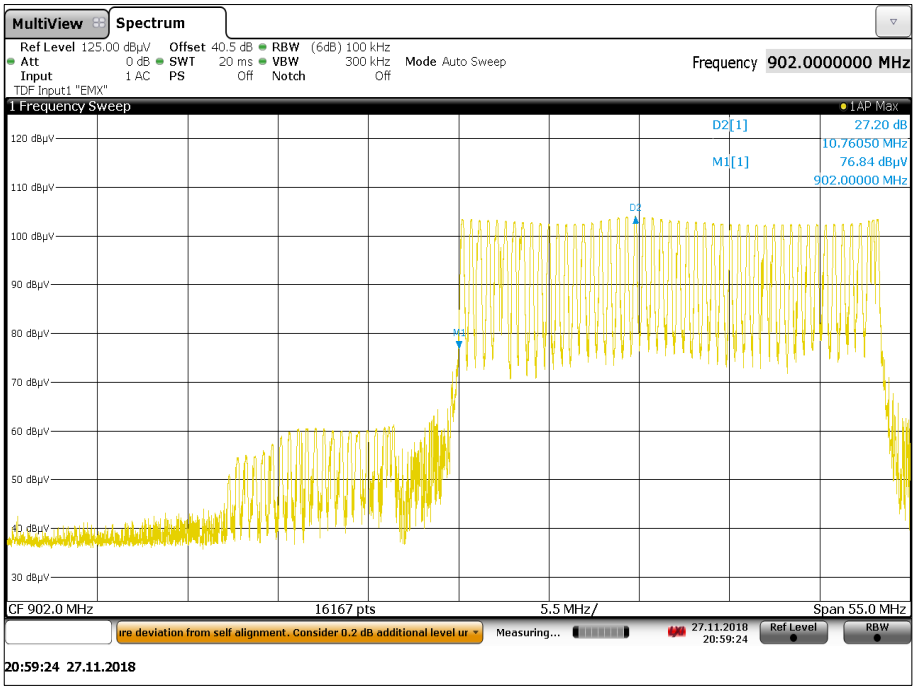


Figure 11 - Hopping 902 MHz - Measured Frequency 902 MHz

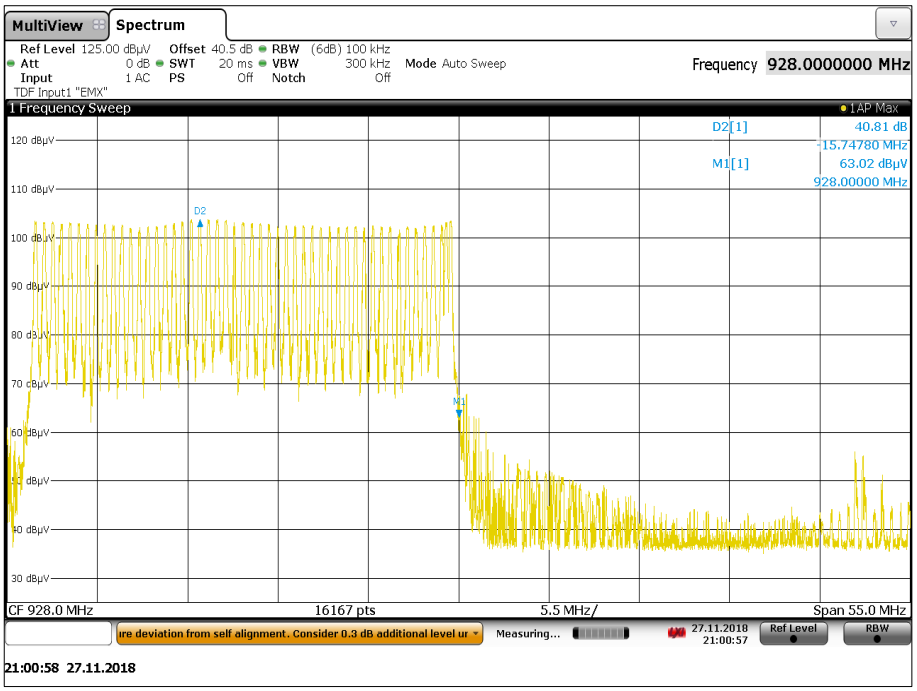


Figure 12 - Hopping 928 MHz - Measured Frequency 928 MHz

FCC 47 CFR Part 15, Limit Clause 15.247 (d)

20 dB below the fundamental measured in a 100 kHz bandwidth using a peak detector. If the transmitter complies with the conducted power limits, based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB below the fundamental instead of 20 dB.

Industry Canada RSS-247, Limit Clause 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

2.5.7 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 5.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Screened Room (5)	Rainford	Rainford	1545	36	23-Jan-2021
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
Cable (Rx, Km-Km 2m)	Scott Cables	KPS-1501-2000-KPS	4526	6	26-Apr-2019
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	05-Feb-2019
Double Ridged Waveguide Horn Antenna	ETS-Lindgren	3117	4722	12	01-Mar-2019
Mast Controller	Maturo Gmbh	NCD	4810	-	TU
Tilt Antenna Mast	Maturo Gmbh	TAM 4.0-P	4811	-	TU
9m N type RF cable	Rosenberger	2303-0 9.0m PNm PNm	4827	6	04-Jan-2019
Hygrometer	Rotronic	HP21	4989	12	26-Apr-2019
EMI Test Receiver	Rohde & Schwarz	ESW44	5084	12	12-Sep-2019

Table 13

TU - Traceability Unscheduled

2.6 Spurious Radiated Emissions

2.6.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (d) and 15.205
Industry Canada RSS-247, Clause 5.5
Industry Canada RSS-GEN, Clause 6.13

2.6.2 Equipment Under Test and Modification State

Free standing blast controller, S/N: 1030002244 - Modification State 0
GS25B18-P1J, S/N: N/A - Modification State 0
DIPL-A0049, S/N: Not Serialised (75943833- TSR0014) - Modification State 0

2.6.3 Date of Test

27-November-2018

2.6.4 Test Method

This test was performed in accordance with ANSI C63.10-2013 clause 6.3, 6.5 and 6.6.
For frequencies > 1 GHz, plots for average measurements were taken in accordance with ANSI C63.10 clause 4.1.4.2.3 to characterize the EUT. Where emissions were detected, final average measurements were taken in accordance with ANSI C63.10 clause 4.1.4.2.2.

Where emissions were found to be pulsed in nature they were measured in accordance with ANSI C63.10 clause 7.5. A peak measurement was performed and then a duty cycle correction factor was added to the peak measurement.

Duty cycle correction factor (dB)
= 20log (On Time/(On Time+Off Time)) = 20log(2.91mS/(2.91mS+1000.00mS)) = -50.74dB
The plots shown are the characterization of the EUT. The limits on the plots represent the most stringent case for restricted bands, (74/54 dBuV/m) when compared to 20 dBc outside restricted bands. The limits shown have been used as a threshold to determine where further measurements are necessary. Where results are within 10 dB of the limits shown on the plots, further investigation was carried out and reported in results tables.

Over the range 614 MHz to 960 MHz the -20dBc limit of 83.78dBuV/m has been shown.

The following conversion can be applied to convert from dBµV/m to µV/m:
10^(Field Strength in dBµV/m/20).

2.6.5 Environmental Conditions

Ambient Temperature	18.1 °C
Relative Humidity	47.0 %

2.6.6 Test Results

902 to 928 MHz FHSS Transmitter

Frequency (MHz)	Level	Limit	Margin	Detector	Unit	Angle (°)	Height (cm)	Polarisation
121.790	36.2	43.5	-7.3	Q-Peak	dBuV/m	163	100	Vertical
149.995	39.3	43.5	-4.2	Q-Peak	dBuv/m	255	100	Vertical
400.015	36.9	46.0	-9.1	Q-Peak	dBuV/m	347	127	Vertical
250.002	44.1	46.0	-2.0	Q-Peak	dBuv/m	173	107	Horizontal

Table 14 – Frequency Hopping - 30 MHz to 1 GHz - EUT Orientation: X

No other emissions were detected within 10 dB of the limit.

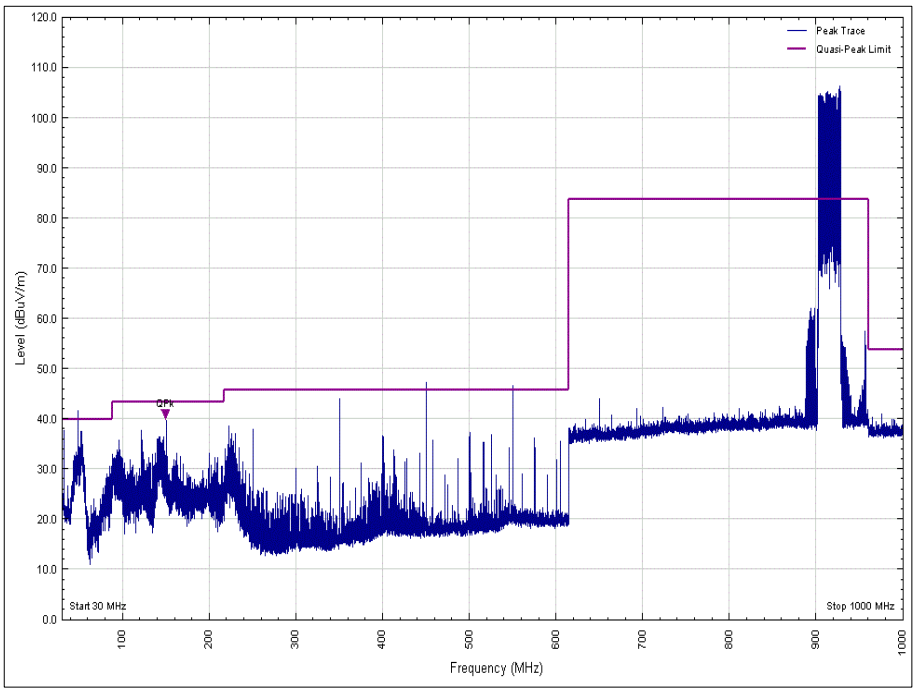


Figure 13 - Frequency Hopping - 30 MHz to 1 GHz
Polarity: Vertical, EUT Orientation: X

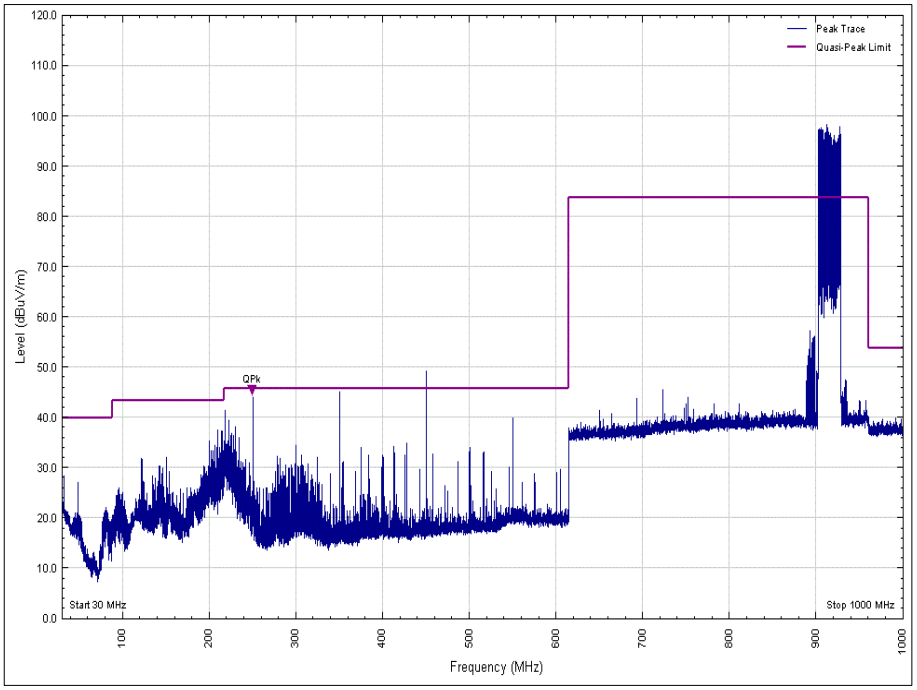


Figure 14 - Frequency Hopping - 30 MHz to 1 GHz
Polarity: Horizontal, EUT Orientation: X

Frequency (MHz)	Level	Limit	Margin	Detector	Unit	Angle (°)	Height (cm)	Polarisation
*								

Table 15 - Frequency Hopping – 1 GHz to 10 GHz - EUT Orientation: X

*No emissions were detected within 10 dB of the limit.

Remarks

Average levels were determined by subtracting the duty cycle correction factor (as calculated in section 2.6.4) from the peak level. The average level of all emissions had a margin of more than 10 dB from the applicable limit.

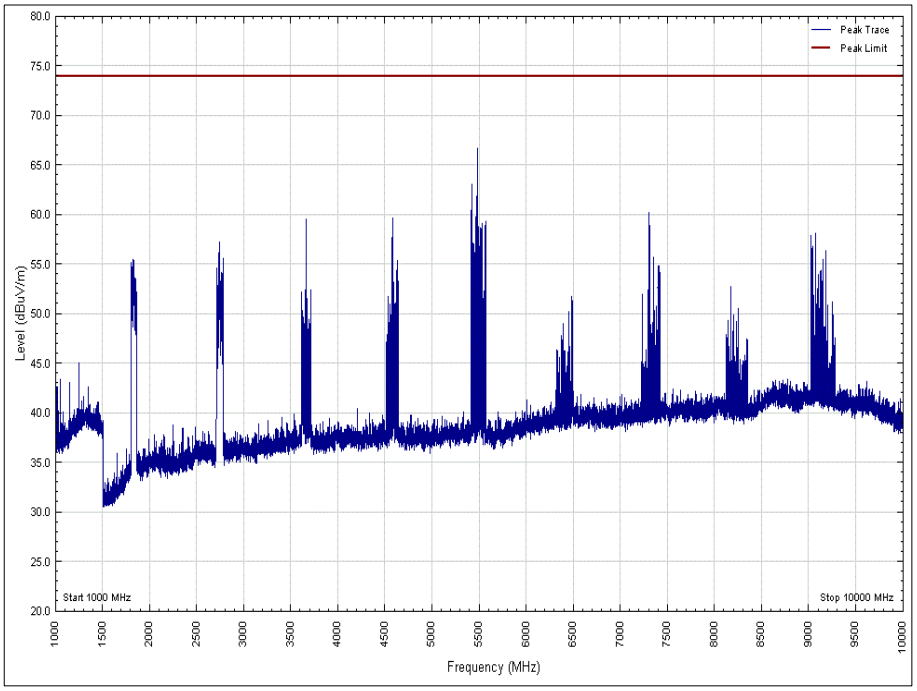


Figure 15 - Frequency Hopping - 1 GHz to 10 GHz Peak Polarity: Vertical, EUT Orientation: X

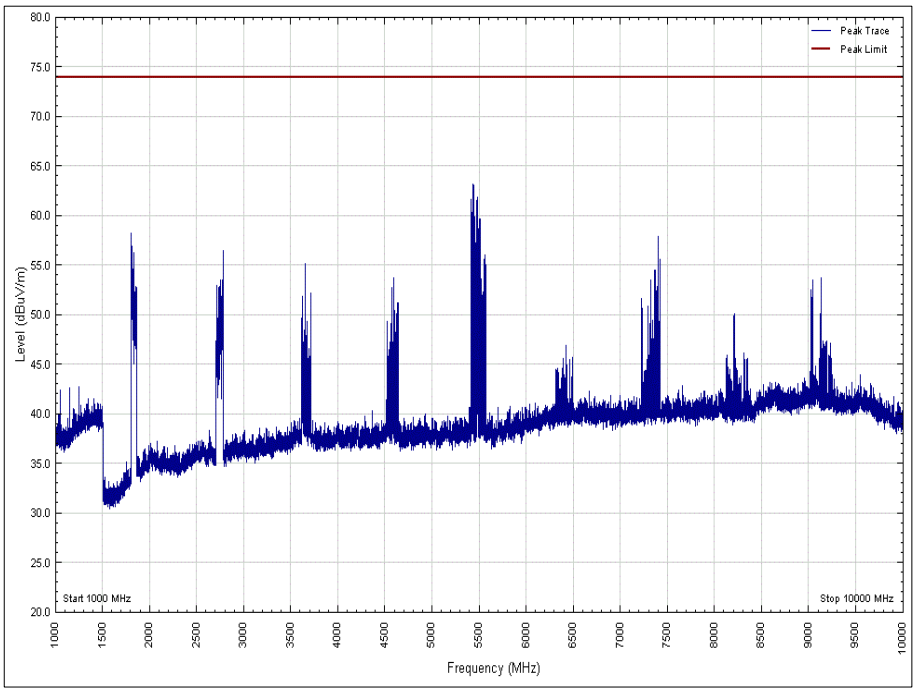


Figure 16 - Frequency Hopping - 1 GHz to 10 GHz Peak
Polarity: Horizontal, EUT Orientation: X

FCC 47 CFR Part 15, Limit Clause 15.247 (d)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in 15.209(a)

Industry Canada RSS-247, Limit Clause 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

2.6.7 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 5.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Pre-Amplifier	Phase One	PS04-0086	1533	12	12-Jan-2019
18GHz - 40GHz Pre-Amplifier	Phase One	PSO4-0087	1534	12	02-Feb-2019
Screened Room (5)	Rainford	Rainford	1545	36	23-Jan-2021
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
Digital Multimeter	Iso-tech	IDM-101	2895	12	04-Oct-2019
Antenna with permanent attenuator (Bilog)	Chase	CBL6143	2904	24	08-Aug-2019
1501A 4.0M Km Km Cable	Rhophase	KPS-1501A-4000-KPS	4301	12	19-Feb-2019
1GHz to 8GHz Low Noise Amplifier	Wright Technologies	APS04-0085	4365	12	25-Oct-2019
1 metre K-Type Cable	Florida Labs	KMS-180SP-39.4-KMS	4520	12	13-Feb-2019
Cable (Rx, Km-Km 2m)	Scott Cables	KPS-1501-2000-KPS	4526	6	26-Apr-2019
High Pass Filter (4GHz)	K&L Microwave	11SH10-4000/X18000-0/0	4599	12	04-Sep-2019
Double Ridged Waveguide Horn Antenna	ETS-Lindgren	3117	4722	12	01-Mar-2019
Mast Controller	Maturo Gmbh	NCD	4810	-	TU
Tilt Antenna Mast	Maturo Gmbh	TAM 4.0-P	4811	-	TU
9m N type RF cable	Rosenberger	2303-0 9.0m PNm PNm	4827	6	04-Jan-2019
4dB Attenuator	Pasternack	PE7047-4	4935	12	28-Nov-2018
Hygrometer	Rotronic	HP21	4989	12	26-Apr-2019
EMI Test Receiver	Rohde & Schwarz	ESW44	5084	12	12-Sep-2019
EmX Software	TUV SUD	EmX	5125	-	Software

Table 16

TU - Traceability Unscheduled

2.7 Frequency Hopping Systems - 20 dB Bandwidth

2.7.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (a)(1)
Industry Canada RSS-247, Clause 5.1

2.7.2 Equipment Under Test and Modification State

Free standing blast controller, S/N: 1030002244 - Modification State 0

2.7.3 Date of Test

11-December-2018

2.7.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 6.9.1.

2.7.5 Environmental Conditions

Ambient Temperature	22.4 °C
Relative Humidity	35.1 %

2.7.6 Test Results

902 to 928 MHz FHSS Transmitter

20 dB Bandwidth (kHz)		
902 MHz	915 MHz	928 MHz
164.5	179.5	16.54

Table 17

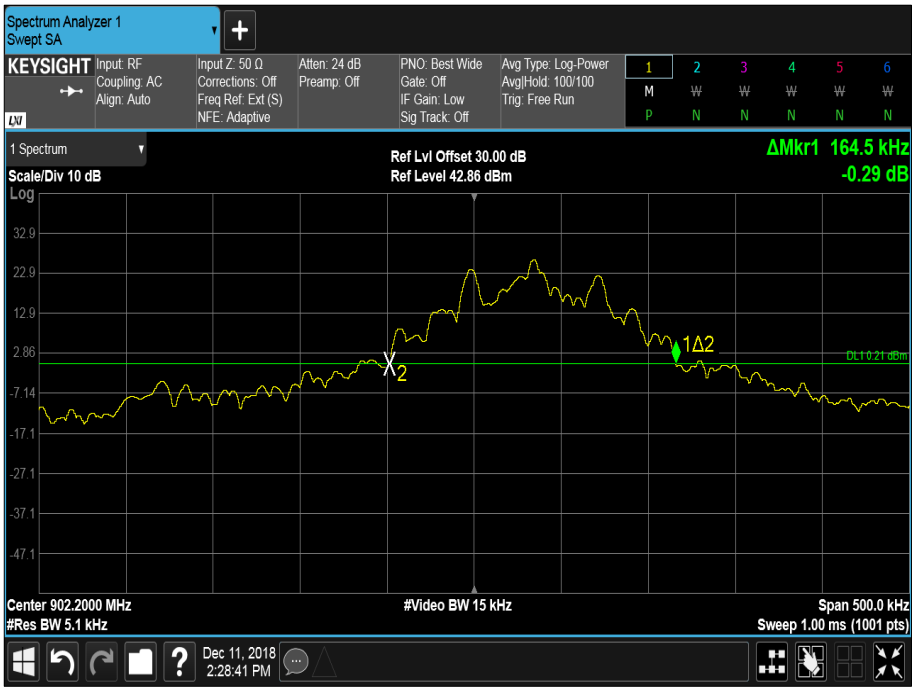


Figure 17 - 902 MHz

Figure 18 - 915 MHz

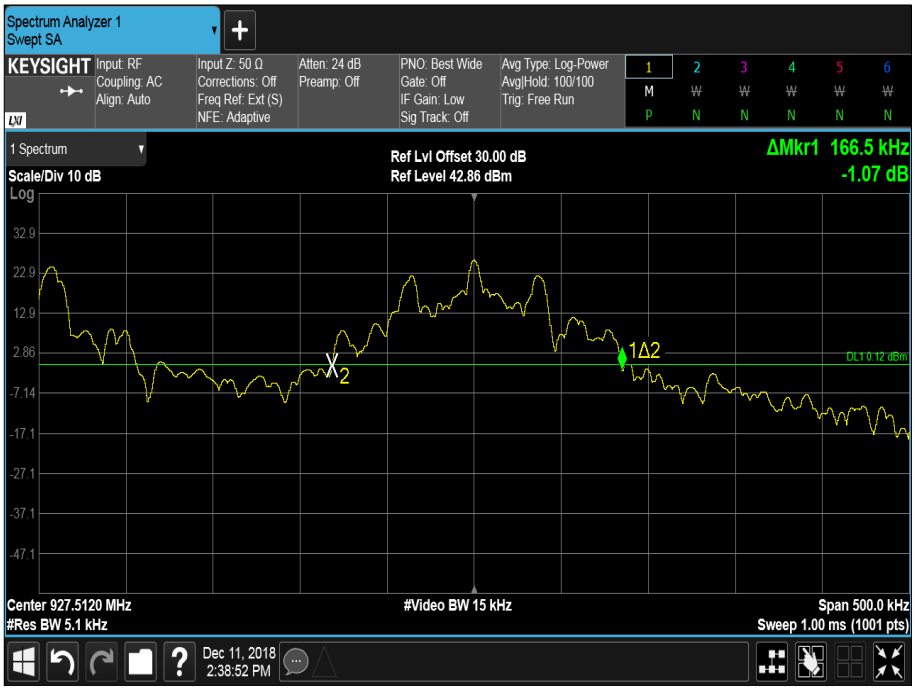


Figure 19 - 928 MHz

FCC 47 CFR Part 15, Limit Clause 15.247 (a)(1)(i) and Industry Canada RSS-247, Limit Clause 5.1 (3)

The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

2.7.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Standard	Rohde & Schwarz	XSRM	1316	6	16-Apr-2019
Hygrometer	Rotronic	A1	1388	12	20-Jun-2019
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	16-Apr-2019
Attenuator (30dB, 100W)	Weinschel	48-30-43	4871	12	17-Jul-2019
EXA	Keysight Technologies	N9010B	4969	12	21-Dec-2018

Table 18

2.8 Restricted Band Edges

2.8.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.205
Industry Canada RSS-GEN, Clause 8.10

2.8.2 Equipment Under Test and Modification State

Free standing blast controller, S/N: 1030002244 - Modification State 0
GS25B18-P1J, S/N: N/A - Modification State 0
DIPL-A0049, S/N: Not Serialised (75943833- TSR0014) - Modification State 0

2.8.3 Date of Test

27-November-2018

2.8.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 6.10.5.

The following conversion can be applied to convert from dBµV/m to µV/m:
10^(Field Strength in dBµV/m/20).

2.8.5 Environmental Conditions

Ambient Temperature	18.1 °C
Relative Humidity	47.0 %

2.8.6 Test Results

902 to 928 MHz FHSS Transmitter

Mode	Frequency (MHz)	Measured Frequency (MHz)	Peak Level (dBµV/m)
Hopping	614	614	36.44
Hopping	960	960	41.06

Table 19

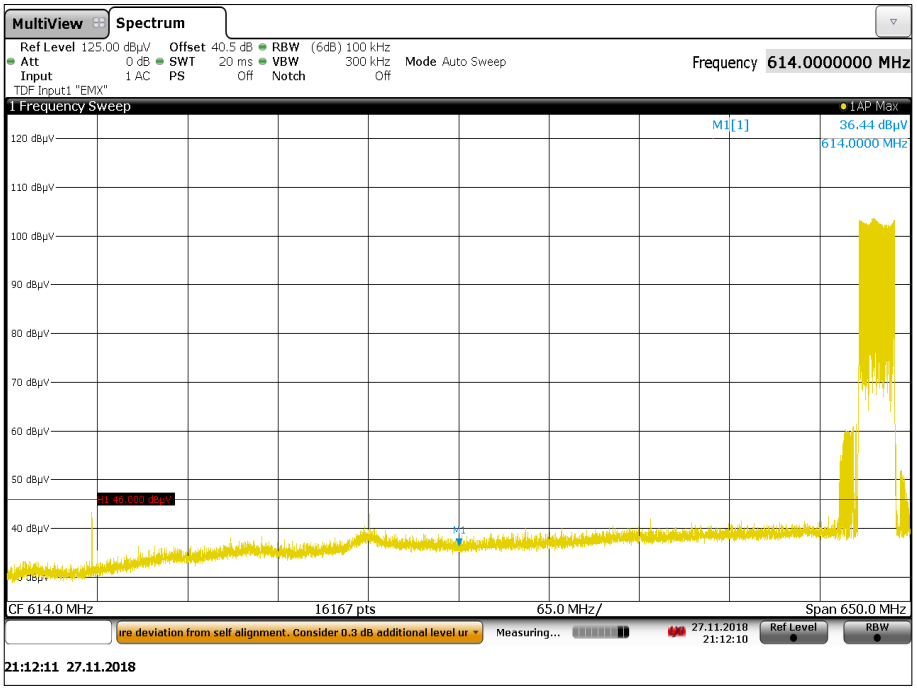


Figure 20 - Hopping 614 MHz - Measured Frequency 614 MHz - Peak

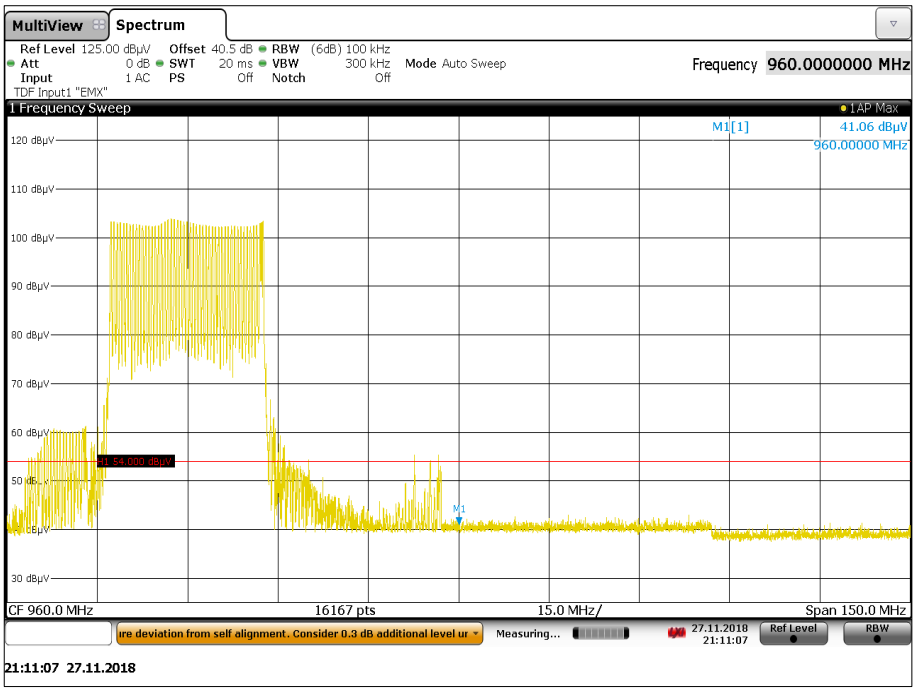


Figure 21 - Hopping 960 MHz - Measured Frequency 960 MHz - Peak

FCC 47 CFR Part 15, Limit Clause 15.209

Frequency (MHz)	Field Strength (µV/m at 3 m)
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

Table 20

Industry Canada RSS-GEN, Limit Clause 8.9

Frequency (MHz)	Field Strength (µV/m at 3 metres)
30-88	100
88-216	150
216-960	200
Above 960*	500

Table 21

*Unless otherwise specified, for all frequencies greater than 1 GHz, the radiated emission limits for licence-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a linear average detector function having a minimum resolution bandwidth of 1 MHz. If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for such factors as pulse desensitization to ensure the peak emission is less than 20 dB above the average limit.

2.8.7 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 5.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Screened Room (5)	Rainford	Rainford	1545	36	23-Jan-2021
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
Cable (Rx, Km-Km 2m)	Scott Cables	KPS-1501-2000-KPS	4526	6	26-Apr-2019
Double Ridged Waveguide Horn Antenna	ETS-Lindgren	3117	4722	12	01-Mar-2019
Mast Controller	Maturo Gmbh	NCD	4810	-	TU
Tilt Antenna Mast	Maturo Gmbh	TAM 4.0-P	4811	-	TU
9m N type RF cable	Rosenberger	2303-0 9.0m PNm PNm	4827	6	04-Jan-2019
Hygrometer	Rotronic	HP21	4989	12	26-Apr-2019
EMI Test Receiver	Rohde & Schwarz	ESW44	5084	12	12-Sep-2019

Table 22

TU - Traceability Unscheduled

3 Photographs

3.1 Test Setup Photographs

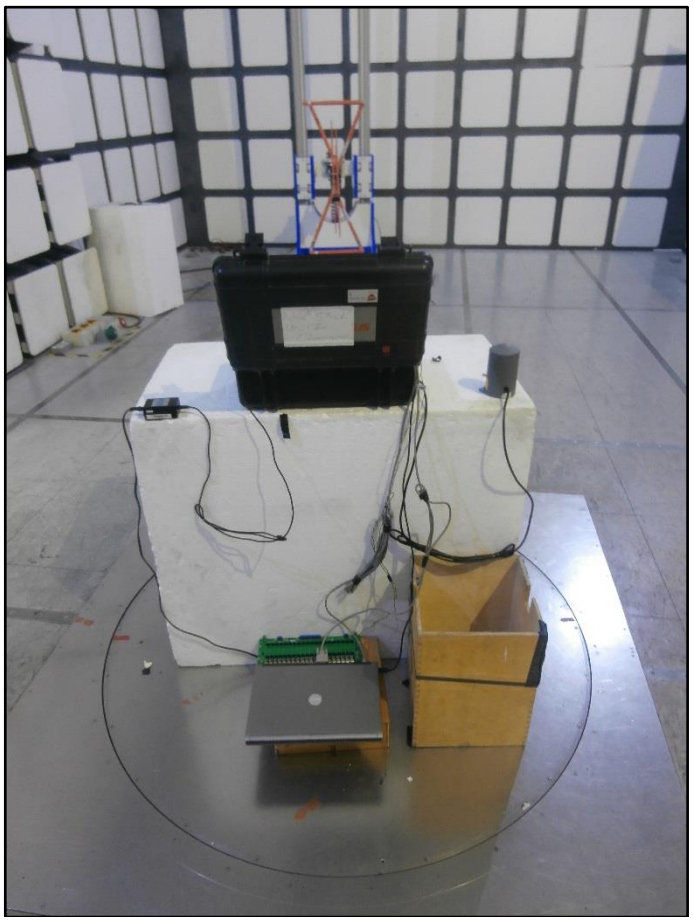


Figure 22 – Spurious Emissions 30 MHz to 1 GHz

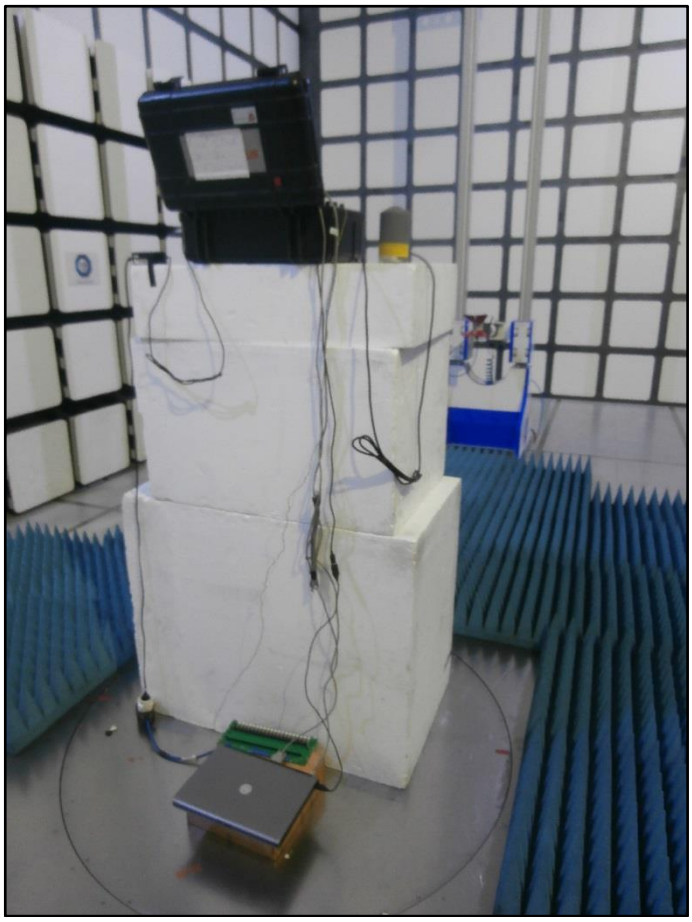


Figure 23 – Spurious Emissions 1 GHz to 10 GHz

4 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

Test Name	Measurement Uncertainty
Restricted Band Edges	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB
Frequency Hopping Systems - 20 dB Bandwidth	± 17.944 kHz
Spurious Radiated Emissions	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB
Authorised Band Edges	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB
Frequency Hopping Systems - Number of Hopping Channels	-
Frequency Hopping Systems - Channel Separation	± 17.944 kHz
Frequency Hopping Systems - Average Time of Occupancy	-
Maximum Conducted Output Power	± 3.2 dB

Table 23